

Single-Port Laparoscopic Right Hemicolectomy: The Learning Curve

Jacob R. Hopping, MD, Ovunc Bardakcioglu, MD

ABSTRACT

Background and Objectives: Single-port laparoscopic colectomy is described as a new technique in colorectal surgery. The initial case reports show the safety and feasibility, but the learning curve for this technique is unknown.

Methods: Between July 2009 and September 2010, 20 consecutive patients with an indication for right hemicolectomy underwent a single-port laparoscopic approach without bias in selection. The only exclusion criterion was a prior midline laparotomy. The patients were followed up for 30 days. Chart review was completed for up to 35 months to assess long-term morbidity and mortality rates.

Results: The median age was 65 years (range, 59–88 years). Ninety percent of patients were men. The median body mass index was 28 kg/m² (range, 20–35 kg/m²). Seventy-five percent of patients had significant comorbidities with an American Society of Anesthesiologists class of 3 or 4. The estimated blood loss was 25 mL (range, 25–250 mL). The median number of pathologic lymph nodes for patients diagnosed with adenocarcinoma was 16 (range, 8–23). There was one conversion to hand-assisted laparoscopic (case 6) and one to open colectomy (case 9) because of the inability to achieve safe vessel ligation. The median hospital stay was 4.5 days (range, 3–7 days). The length of stay for the first 10 patients was 5.1 days, and it was 3.9 days for the last 10 patients ($P = .045$). There were no significant postoperative complications within 30 days. The mean operative time for the first 10 cases was 198 minutes (range, 148–272 minutes), and it was 123 minutes

(range, 98–150 minutes) for the subsequent 10 cases ($P = .0001$). All intraoperative complications (minor bleeding) occurred within the first 10 patients, with no significant bleeding recorded for the last 10 cases.

Conclusion: Single-port laparoscopic right hemicolectomy can be safely performed in patients who are candidates for conventional or hand-assisted right hemicolectomy with very low intraoperative and postoperative complication rates. The 30-day morbidity rate remained low with this technique. The higher technical difficulty compared with conventional laparoscopy is reflected in the longer initial operative times. The learning curve for a surgeon with advanced laparoscopic skills and adequate procedure numbers seems to be short, requiring approximately 10 cases to decrease operative times to baseline. The role and feasibility of broad adaptation for single-incision laparoscopy in colorectal surgery need to be further evaluated in larger case series and trials.

Key Words: Single port, Single incision, Laparoscopic, Right hemicolectomy, Learning curve.

INTRODUCTION

A large body of evidence now exists supporting the safety and feasibility of single-port laparoscopic colectomy (SPLC). However, few authors have discussed the learning curve of this technique in colon surgery. In addition, a majority of the literature is multi-institutional, making it difficult to accurately gauge the learning curve of a single surgeon. It has been noted by Waters et al.¹ that there is little learning curve for experienced surgeons, but no specific mention of case volume to obtain proficiency is found in the literature.

According to *Webster's Dictionary*, the “learning curve” is “a curve plotting performance against practice.”² In business the learning curve is used to examine decline in unit cost with cumulative production. In surgery the term is often used to describe the number of cases performed and not the plot of a specific line.³ In our first 20 cases of single-port laparoscopic right hemicolectomy, we note a distinct and statistically significant decrease in operative

Department of Surgery, Saint Louis University, St Louis, MO, USA (Dr Hopping).

Division of Colon and Rectal Surgery, Department of Surgery, University of Nevada School of Medicine, Las Vegas, NV, USA.

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Dr. Bardakcioglu is currently a proctor with Intuitive Surgical and has received honoraria from Covidien and Niti Surgical Solutions.

Address correspondence to: Ovunc Bardakcioglu, MD, 3635 Vista Ave, Desloge Towers, Third Floor, St Louis, MO 63110, USA. Telephone: (314) 577-8619, Fax: (314) 771-1945, E-mail: Ovunc.Bardakcioglu@mac.com

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time and hospital length of stay comparing our first 10 cases with our second 10 cases. In showing a decrease in operating time and hospital stay in association with a defined learning curve, we can assume a decreased cost to the patient and health care system when evaluating new techniques in surgery.

MATERIALS AND METHODS

Patient Selection

Patients were selected in order as they were seen in the clinic from the practice of a single laparoscopic fellowship-trained colorectal surgeon at a university institution from February 2009 through September 2010. The only exclusion criterion was previous abdominal surgery. Patients were selected if they had an indication for laparoscopic right hemicolectomy. All patients had right-sided lesions. The following data were collected: patient age and sex, body mass index, comorbidities, American Society of Anesthesiologists class, length of surgery, estimated blood loss, pathology before and after resection, intraoperative complications, conversion to conventional laparoscopy and open surgery, length of parenteral narcotic requirement, length of stay, and postoperative morbidity and death within 30 days.

All data were collected retrospectively, and institutional review board approval was not requested. All patients were told of the alternative surgical approaches, including open surgery and conventional laparoscopic surgery, beforehand and agreed to undergo single-incision surgery.

Operative Technique

All patients had a periumbilical incision with a trocar system including three 5-mm ports for access. A straight bowel grasper and a vessel sealing device were used for dissection and a flexible tip or 30° laparoscope for visualization. The anastomosis was performed extracorporeally in all patients. For a full description, one may refer to our previously published article.⁴

Statistical Analysis

The Student *t* test with a confidence interval of 95% was used to compare datasets between the 10-patient cohorts.

RESULTS

In the 18 months of patient selection, 20 right hemicolectomies were performed by a single-port laparoscopic

technique. There were 18 male patients and 2 female patients. The mean age was 66 years (SD, 9.6 years). The mean body mass index was 28 kg/m², with an SD of 3.8 kg/m². Two cases were converted for better visualization because of minor bleeding. One case was converted to a hand-assisted laparoscopic approach and one to open surgery. Median blood loss was 25 mL (in 18 of 20 cases), with 250 mL of blood loss being reported in 2 cases (Table 1). All occurrences of bleeding >25 mL were recorded in the first 10 cases (cases 1, 6, and 10). There were no other intraoperative complications. Thirty-day postoperative complications included one case of alcohol withdrawal requiring a longer recovery and hospital length of stay, one wound infection, and one case of *Clostridium difficile* colitis requiring appropriate antibiotic coverage. There was one death, a myocardial infarction occurring at 17 months unrelated to surgery. The mean hospital length of stay was 5 days, with a range of 2 to 7 days. There was a significant difference in length of stay between the first 10 cases and second 10 cases (Figure 1). There were no readmissions within a 30-day period. The median operative time was 156.5 minutes, with a range of 98 to 272 minutes, which is consistent with that previously reported. There was a statistically significant difference in mean operative time between the first 10 cases and second 10 cases (Figure 2).

DISCUSSION

The learning curve for SPLC has been discussed in the literature but not specifically studied.⁵ Some authors argue that the learning curve is flat for an experienced laparoscopic surgeon.⁶ Others have reported an undetermined learning curve that warrants further study.⁷

Table 1.
Perioperative Data

	Cases 1-10	Cases 11-20	<i>P</i> Value
LNH ^a	12.6	11	.68
OT ^a , min	198	118.4	.0001 ^c
EBL ^a	82.5	25	.059
COMP ^{a,b}	2	0	NA
LOS ^a , d	5.1	3.9	.045 ^c
NR ^a , d	2.6	2.1	.094

^aCOMP = intraoperative complications (total), EBL = estimated blood loss, LNH = lymph nodes harvested, OT = operative time, LOS = length of stay, NR = narcotic requirement.

^bIntraoperative complications comprised two cases of bleeding requiring conversion to hand-assisted conventional laparoscopy and one case of bleeding requiring open surgery.

^cStatistically significant.

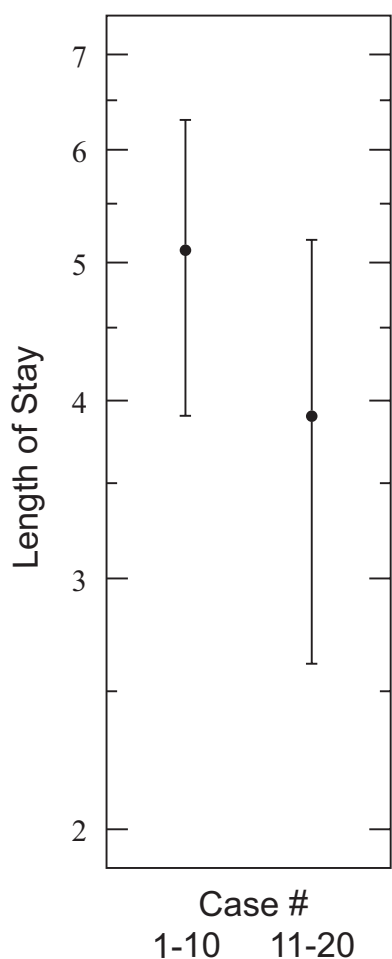


Figure 1. The mean operative time for cases 1 through 10 was 198 minutes, and the mean operative time for cases 11 through 20 was 118 minutes ($P = .0001$).

Establishing the learning curve for any procedure is important because it gives a baseline for efficiency in learning new procedures that may be beneficial to patient care. The learning curve for a solitary surgeon involved in this study was 10 patients, represented graphically in **Figure 3**. Little is discussed in the literature about the number of cases to achieve proficiency in the SPLC technique. One report mentions an initial 16 cases for a similarly experienced surgeon.¹ The same authors report no difference in the mean operative time comparing SPLC with conventional laparoscopy. This is the first study to compare two cohorts of SPLC patients. We show a decrease in length of hospital stay and overall operative time after the established learning curve for one surgeon.

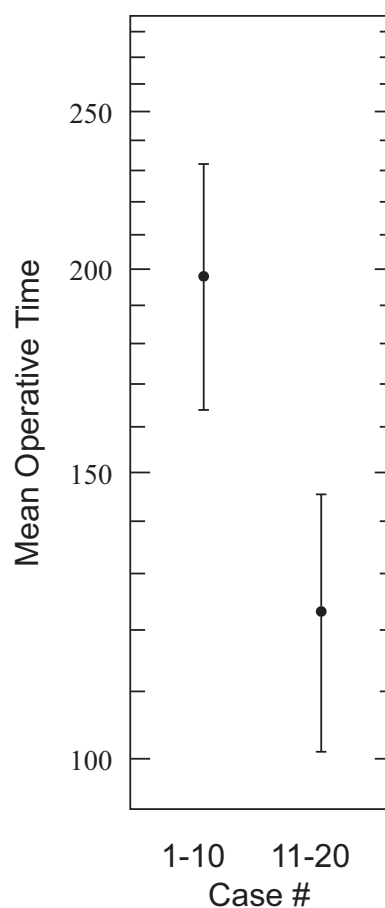


Figure 2. The mean length of stay was 5.1 days for cases 1 through 10 and 3.9 days for cases 11 through 20 ($P = .045$).

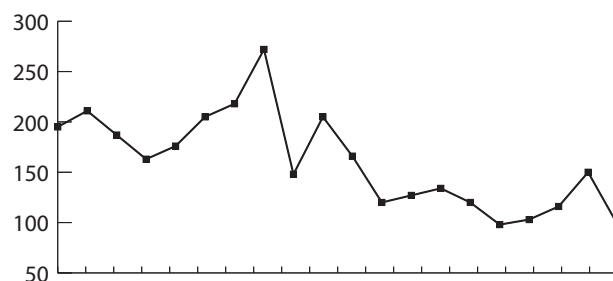


Figure 3. Operative-time learning curve with cases 1 through 20 listed sequentially.

It is well established that longer operating times result in increased morbidity and mortality rates.⁸ According to the American College of Physicians, there is a direct link between pulmonary complications such as pneumonia

and surgery lasting >3 hours.⁹ In colorectal surgery, it has been shown that an operative time >240 minutes increases risk and length of stay.¹⁰

The risk of peripheral nerve injury in surgery has been studied, which is largely related to patient positioning.¹¹ It can be postulated that a longer time in the lithotomy position may result in femoral or brachial plexus nerve injury. Although a direct length has not been found, decreased operating times theoretically reduce the risk of deep venous thrombosis formation.¹² There are also uncommon reports of acute compartment syndrome of the lower extremities after a prolonged lithotomy position.¹³

It is well known that decreased hospital stay is also beneficial because it decreases the costs to the patient as well as the health care system. With the prevalence of drug-resistant and multidrug-resistant organisms, decreasing the length of stay (and therefore exposure risk) is an important outcome in surgical care.

Similar to the learning curves discussed at the origin of single-incision laparoscopic cholecystectomy, we believe that SPLC can be performed without increasing costs or complications after the initial learning curve.³ This study is limited by its size, and more research should be performed on the subject. We believe that these data establish that a learning curve does exist and is likely different for surgeons with differing levels of experience.

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